Management and high technology

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MANAGEMENT AND HIGH TECHNOLOGY

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INTRODUCTION

The first IFSAM convention deals with management and high technology[1]. We could very well have imagined to devote it to management and haute cuisine. We would then have dealt with business lunches. We could also have imagined to devote it to management and tourism or to management and politics... But, in each case only a limited aspect of management would have been explored.

Why should things differ with high technologies? Leonardo Da Vinci, who must have been a high technology pioneer in his own time since he had already invented airplanes, submarines and a host of other machines in the late sixteenth century, most likely would not have thought of establishing links between engineering and organizational science. The reason why the link between the two must appear more obvious today lies on the fact that technical know-how no longer rests on one single individual but on a team of individuals who manage to combine the many facets of their expertise. Incidentally, they must also publicize their work to raise the necessary funds.

In the case of high technology, we will see that management is both object (high technology modifies it) and subject (it affects the innovation process).

Parts one and two of this presentation will deal with these aspects. Part three will further show how management itself turns into a high technology.

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1 Technology must not be mistaken for science. The former consists of a "series of processes based upon non-empirical, scientific knowledge which are implemented with a view to reaching a specific goal." (Paul FOULQUIE, *Dictionnaire de la langue philosophique*. P.U.F., 1982, p. 714). Conversely, the latter "aims at knowledge itself and not at its practical uses"(ibid., p. 656).

1- A NEW, HIGH TECHNOLOGY-INSPIRED MANAGEMENT STYLE

Management, an organizational science, necessarily adapts to the constraints that the environment -particularly the technological one- imposes on business firms, as well as to the many opportunities it offers them.

The paradoxical relation existing between management and the technological environment

Change constitutes a **constraint** inasmuch as advanced technologies prompt firms to implement growingly sophisticated and protracted processes. Thus their overheads increase, as does the payback time needed to recoup the initial capital investment. Risk is then augmented; the more so as innovation processes cannot be easily programmed.

Besides, high technology grants firms a temporary competitive **advantage** and allows them to enjoy a situation of monopoly for a time.

The following **paradox** appears:
- on the one hand, high technology upsets a given environment as it reinforces their need for more predictability in order to face increased risk.
- on the other hand, high technology allows firms to control this environment (if only temporarily so) by giving it an advantage over its competitors.

The technological environment modifies the nature of management methods

Management as a technology has had to adapt to this situation:
- by organizing the knowledge creation processes in order to play an active role in the evolution of the environment - as we will see in the second part of this presentation.
- by putting to good use some of the possibilities of high technology, particularly in the field of information processing, to try to reduce the degree of uncertainty over the evolution of this environment. This is what we will see now.

The extraordinary development of the possibilities of information processing, in volume, speed and complexity, as well as its remarkably low cost, has given management new tools.

The very limits of the manual information processing methods used in the past naturally led to **hypothetico-deductive approaches** which were economical in all respects and, by applying a predetermined logic, aimed at validating the likelihood of an intuition (hypothesis).

Today, the possibility to use countless statistical methods (correlations, sampling, surveys...) and to analyze quickly the resulting data allows for an **inductive approach**.

A systematic, in depth, exploration of the field leads to the discovery of new rules and

new causalities, making experience somewhat redundant in the formulation of intuitions. Thus, for example, marketing departments try out behavior models in order to reduce uncertainty as to the consumers' reaction to a new product or service. In the fields of accounting or of finance, computers now make it possible to test the financial impact of different events and data banks enhance our capacity to formulate sound diagnostics. Likewise, the association between data processing and production management creates the conditions for the development of Just-In-Time and for the increased customization of products. There is a long list of such examples, which prove that management could not cope without high technologies.

It may be useful to note here that information technologies help solve the very problems that they created by making such a wealth of information available.

2- MANAGING INNOVATING STRUCTURES

Innovation is a factor of production as well as a collective commodity

Technology, the practical application of science, has now become a **factor of production**, together with labor and capital. However, it does not follow the rules, which governs the other factors of production since we are dealing here with a collective commodity, which knows no barriers in space. There is practically no transport cost but only a transport lag-time. The marginal cost of faxing a new chemical formula to someone residing thousands of miles away is negligible. It is not always in the best interest of the inventor of the formula or his employer to publicize this new knowledge. Yet, in a few instances, an invention should be publicized as broadly as possible, for example, if a firm harbors any hope of setting new national or international standards, which might be favorable to it. Thus, controlling the spread of intellectual production becomes a new branch of corporate management.

Contrary to what happens with physical factors of production, the transmission of a new knowledge to a third person does not necessarily deprive the inventor of his right to use it. Indeed, the very nature of knowledge makes it a **collective commodity**, with one specificity though: namely that by disseminating an invention an inventor loses the monopoly he enjoyed over its use, and thus decreases its **market value**. So, what gives knowledge an economic value is not so much quantity as the capacity to use it before your competitors do and the managerial skills to make full use of it. For a firm, the best way to gain a headstart and to keep it over time is to produce knowledge within its own structure and to control its use.

Management turns innovation into collective knowledge

One difficulty lies in the fact that new knowledge is often discovered by individuals and has to be transformed into **collective knowledge** before it can become economically relevant. Though not the inventor, the manager must create the most favorable conditions for this transformation. At this point two different types of knowledge must be distinguished[2] :

2 This development owes much to Ikujiro NONAKA in The Knowledge-creating Company.

- **explicit** knowledge, which is formalized and easy to communicate.
- **implicit** knowledge, which is hard to formalize (I know more than I can formulate) or to communicate, which is appropriated by individuals and linked to action (know-how) as well as to certain types of behavior. Four different models of transmission of knowledge result from this:

Origin of knowledge ➨ Destination of knowledge ➪	Explicit	Implicit
Explicit	2	3
Implicit	4	1

- Model 1 corresponds to socialization in the arts (the training of craftsmen). Knowledge is publicized very slowly. Its environment lends much weight to the value of behavior (code of conduct). The capacity to innovate is limited.
- Model 2 corresponds to the rational (quick and cheap) dissemination of rational knowledge. Teaching functions essentially along these lines. Creation stems from original combinations ("lego" effect) and breakthroughs are rare.
- Model 3 corresponds to an intuition turned into new scientific knowledge. It is a major source of innovation.
- Model 4 corresponds to an intuition, which stems from scientific knowledge. It often precedes model 3 and is also a major source of innovation.

An innovating firm must combine all four models. A good manager must create the conditions which allows them to coexist and, principally, the structures most conducive to model 3 and model 4 transformations.

Management may stimulate innovation thanks to metaphors, analogies, equivoque and ambiguity

To be **favorable to creativity, structures** must necessarily make room for implicit knowledge, that is to knowledge, which cannot be fully formulated. Thus, we are not dealing here with a clockwork organizational model (in which all parts permanently play a specific role, with the concurrent risk that one defective part will block the whole system) but with a living organism equipped with many compensating mechanisms which allow it to adapt to new situations.

Management must foster creation by not banishing elements, which may appear unscientific. It must allow for projects, which are based on **metaphors**, the brainchildren of persons who imagine a sort of kinship between two apparently disjointed concepts. Circulating a metaphor among several individuals to elicit their reactions may enrich it. For example, the team of experts who perfected the Honda City car had chosen the following slogan: "The theory of automobile evolution" [3]. That metaphor associated two contradictory concepts, that of a machine (the automobile) and that of a living organism (evolution). It raised the following question: If a car were a living organism, how would it evolve? That approach to the design of a new model allowed Honda to produce an original vehicle.

Harvard Business Review, November-December 1991, pp 96-104.

3 Cf. NONAKA, op cit.

Management must also learn how to accept projects, which are based on **analogies**, as analogies make for the transfer of innovation from one field to another. Ikujiro NONAKA cites the example of the analogy, which was made between the cylinder inside Canon photocopiers and a disposable beer can - also a cylinder. It started the idea of a throwaway photocopier cylinder.

Metaphors and analogies present serious dangers if they constitute ways to avoid the scientific validation of results or sound reasoning. But the intuitions, which underlie them, may also initiate an innovation process based upon rich and otherwise untapped experience.

Lastly, contrary to what is often taught, management cannot shun **equivoque** or **ambiguity** if it wants to enhance creation. Indeed, ambiguity is a way to deal with complex situations. It may, on the one hand, create a source of disorder and perturb the implementation of the best-laid plans; but on the other hand it may foster a wealth of different interpretations and expressions. Ambiguity may also foster peace as it gives everyone leeway to maneuver and negotiate in conflictual situations.

In this respect, public organizations may serve as a model to private organizations since politicians are past masters in the art of cultivating ambiguity. **Ambiguity may cause some disorder when it affects micro-decisions in business firms. Yet, the greater harmony and consensus it also produces in the daily operations of their structures more than offsets that drawback.**

3- RECONCILING SCIENCE AND PRAXIS

So far, we have seen that management was deeply influenced by high technology and that, in return, it could breed technology in business firms by providing a favorable environment. This dialectical relationship with technology has changed management altogether.

Recent shifts in management

Management used to consist mostly of rules which regulated the **exercise of authority** and allowed to "replace objective uncertainty with subjective certainty"[4]. In fact, the environment remains largely uncontrollable and all decision-making processes must cope with its uncertainties and evolutions. This is what we call objective uncertainty.

In order to reduce the degree of complexity of the environment and to build organizational models, it is necessary to design rules and procedures, which apply to situations whose discrepancies with the model, are deliberately ignored. This is subjective certainty. It meets the needs of the different actors of the organization for

4 Martin LANDAU and Donald CHISHOLM. Success oriented vs failure avoidance management in public administration: a reconsideration. Institut de Management Public symposium in Paris, France. 26-27 March, 1992.

security, but is fraught with dangers. Indeed, in extreme cases, when facts do not square with theory, one may be tempted to conclude that the facts themselves are wrong. LANDAU and CHISHOLM think that the Vietnam War provides a good example of the dysfunctions resulting from this type of management. By systematically ignoring the data which did not conform to the staff's plans, the high command lost control over the operations and was belatedly brought back to reality by defeat.

Management also used **technical tools**, which were derived from science, but never really adopted a scientific approach. This was wrongly dubbed "scientific management". Resorting to statistics, operational research, linear algebra or the graph theory does not necessarily imply that one type of approach will be scientific globally. The following example will provide a good illustration: a 10mm wrench need not be precision-made to within one hundredth of a millimeter if one wants to use it to loosen a 9mm bolt. No matter how precise, this tool will just not work for the job at hand.

In its long history, management has seen many of these "wonder" tools come and go, each forgotten after a short period of fame. All played a part in increasing - if only modestly- the efficiency of business firms in specific contexts. Yet at no time could this approach claim to be scientific? It mostly associated techniques which were by and large borrowed from other disciplines and used them until failure proved them inadequate.

Management research may never qualify as a science, if one is to retain the narrow meaning of the word as in "physical science". Management cannot experimentally verify that, all things being equal, the same causes produce the same effects. Conversely management, or at least management research, certainly is one of the human sciences. They do not aim at reducing human behavior to mathematical equations but, thanks to a scientific approach, to lead to a better understanding of observed facts. For example, methods and not results make history a science. The same also applies to management.

<u>Management must allow for error and doubt</u>

The growing complexity of modern economies calls for an increased understanding of the facts. However, a truly scientific approach will become possible only when a few of the traditional values of management cease to stand in the way.

It is first necessary to cultivate the virtues of **doubt**, **uncertainty**, **concern** and of a **critical mind**. Management overrates such "positive" attitudes as those, which are normally attributed to "doers", for example the subjective certainty of the person in charge. As we saw it earlier, management tends to ignore what may create doubt or disorder. Conversely, scientific approaches look into what may question well-established theories. The sources of progress are to be found in anomalies and errors.

Martin LANDAU cites the following anecdote to illustrate the concept of an error

tolerant organization: *an aircraft carrier is sailing in the high seas and has catapulted all of its crafts in the air. When all aircrafts are airborne, a mechanic tells his officers that he has misplaced a wrench on the flight deck. No aircraft can then land as the wrench may be sucked in a jet engine, causing physical damage to the plane and endangering the pilot's life. The control tower radioes to the pilots that they should land on strips in neighboring countries. Meanwhile on the aircraft carrier, a search party tries to locate the misplaced wrench and eventually finds it. The following day, the mechanic who had misplaced his wrench, thus causing millions of dollars worth of unexpected costs to the Navy, was awarded a medal. The rationale was that, if in a similar case the mechanic had not informed his hierarchy of the incident in order to avoid sanction, a serious accident might have happened. Only an exceptional capacity to analyze situations could foster such a seemingly paradoxical - and efficient - line of conduct.*

A scientific approach may run counter to our conceptions of authority, of **discipline** and of the **division of labor**. In so-called "rational" organizations everyone has access to all the information - and only that information- which one needs to discharge one's duty. Moreover, the clear-cut distinction between the definition and the implementation of tasks provides that those in charge of implementing decisions may not question the persons making them, but may only report facts and not opinions to their superiors. These features of taylorism have survived in even the most advanced forms of organizations. Yet science progresses insofar as 1/ information is made accessible to the greatest possible number of people, and 2/ each employee may challenge the work of another employee.

The only question left unanswered is how to **reconcile** the values of the man of action (**decision**) and those of the scientist (**doubt**). Today, big firms are learning how to use both sets. They had already learned how to solve conflict between the necessities of short-term management and strategy by making divisions or branches responsible for the former and headquarters for the latter. They also try to reconcile specific interests and the general welfare of the company by using, in particular, transfer prices within the organization.

<u>Management models become less decision- and more regulation-oriented</u>

In the high technology sector, management by project tends to erase the traditional distinction between executives, the people who are in charge of implementing policy, and managers, the people who act more as consultants or even as researchers for the organization. Academia has long been a good example of the growing diversification of tasks. Indeed, faculty members must devote their time to 1- action (teaching, publishing and consultancy contracts), 2- basic research, and 3- the general management of the structure they work in.

Business firms are now gradually discovering that variety may bring more benefits than dangers. Variety is the necessary counterweight of rigidities in the firms, which must adapt to a changing environment. It is useful as a source of diversity, as biology teaches us. But it is also fraught with dangers as it may trigger conflicts and misunderstandings. **Firms must therefore walk the tightrope between two**

opposites.

Efficiency, measured in terms of the productivity of one given factor or set of factors, could grow thanks to more sophisticated management techniques. But efficiency cannot be confused with **effectiveness**. In theory, we should find the following table:

means results objectives

efficiency

effectiveness

In reality, objectives are often implicit and ambiguous, as we have already seen, and means are not freely chosen; results depend on the means used as well as on their various interactions with the environment. Lastly, information remains imperfect.

A truly scientific approach will perturb and unsettle the beautiful order of this French style garden. It affects the operations of a firm just as democracy affects that of the State. All citizens are entitled to express doubt, questions and criticism. But only the very best elements of a sytem will resist such tough treatment. Thus, business firms will discover the virtues of political regulation.

I would like to conclude that management which is itself both a product of technology and a factor of production of technology may have become a high technology commodity. It is certainly true if this expression encompasses applied science. That would presuppose considerable change in business firms, particularly with the emergence and valorization of doubt. As long as it remains within the limits of method and reason, doubt will both free individuals to create and shake organizations into more adaptability.